

Wetland Turtle Habitats Potentially Impacted by USACE Reservoir Operations

BACKGROUND: Changing water levels or other operations at U.S. Army Corps of Engineers (USACE) reservoirs may impact critical habitat parameters for wetland turtle species.

This technical note identifies wetland turtle species and habitats potentially impacted by USACE reservoir or other water-control projects as reported by resource managers. Current state and/or Federal legal protection status is summarized and USACE Districts and reservoir projects potentially impacted by wetland turtle conservation issues are identified (Table 1). Life-history summaries and habitat requirement descriptions are given for each wetland turtle species identified as potentially impacted at reservoir operations (Figure 1, Table 2). This group includes one Federally threatened, one Federal candidate, and three state protected turtle species. These five species were reported to have presented conservation issues at 50 USACE projects from 8 USACE Districts (4 USACE Divisions).

The collective range for these turtles includes states of the northeastern United States region and Atlantic and Pacific coastlines (Figure 2). Typical habitat includes shallower bodies of water such as wetland habitats including swamps, bogs, wet pastures, ponds, and riparian areas of streams and rivers. Wetland turtles are not associated with the larger rivers of the Mississippi valley watershed. Some of these species are considered semiaquatic. All of these species are omnivorous scavengers, with the bulk of their diet consisting of invertebrates. Destruction of wetland habitat and collection for the pet trade have caused extinction of some populations and severely reduced others.



Spotted Turtle
photo by Dena Dickerson

Wetland Turtles Potentially Impacted by Reservoir Operations		
Turtle Common Name	Scientific Name	Protection Status
Blanding's	<i>Emydoidea blandingii</i>	Federal candidate for protection
Bog	<i>Clemmys muhlenbergii</i>	Federally threatened
Wood	<i>Clemmys insculpta</i>	State protected
Spotted	<i>Clemmys guttata</i>	State protected
Western pond	<i>Clemmys marmorata</i>	State protected

DTIC QUALITY INSPECTED 4

DISTRIBUTION STATEMENT:
Approved for Public Release
Distribution Unlimited

19990521 163

Table 1
Summary of Survey Results, Wetland Turtles

Species	Protection Status		Divisions Identified	Districts Identified	Number	
	State	Federal			District	Total
Blanding's		Candidate for Federal protection	LRD NWD NWD MVD	Huntington Louisville Omaha Rock Island	1 1 14 2	18
Bog		Federally threatened	NAD	New England	8?	8
Wood	State protected		NAD MVD	New England Rock Island St. Paul	1 1? 1	3
Spotted	State protected		LRD NAD	Huntington Louisville Pittsburgh New England	1 2 3 1	6
Western pond	State protected		NWD	Rock Island	18	18
Summary			LRD NAD NWD MVD	Huntington Louisville Pittsburgh New England Omaha Portland Rock Island St. Paul	1 3 3 8 14 18 2? 1	50

? Questions remain about survey response

POINT OF CONTACT: For additional information, contact one of the authors, Ms. Dena D. Dickerson, (601-634-3772, dickerd@ex1.wes.army.mil), Mr. Kevin J. Reine, (601-634-3436, reinek@ex1.wes.army.mil), or Ms. Kim L. Herrmann, (601-634-3689), or the manager of the Ecosystem Management and Restoration Research Program, Dr. Russell F. Theriot, (601-634-2733), therior@ex1.wes.army.mil). This technical note should be cited as follows:

Dickerson, D. D., Reine, K. J., and Herrmann, K. L. (1999). "Wetland turtle habitats potentially impacted by USACE reservoir operations," *EMRRP Technical Notes Collection* (TN EMRRP-SI-04), U.S. Army Engineer Research and Development Center, Vicksburg MS. www.wes.army.mil/el/emrrp

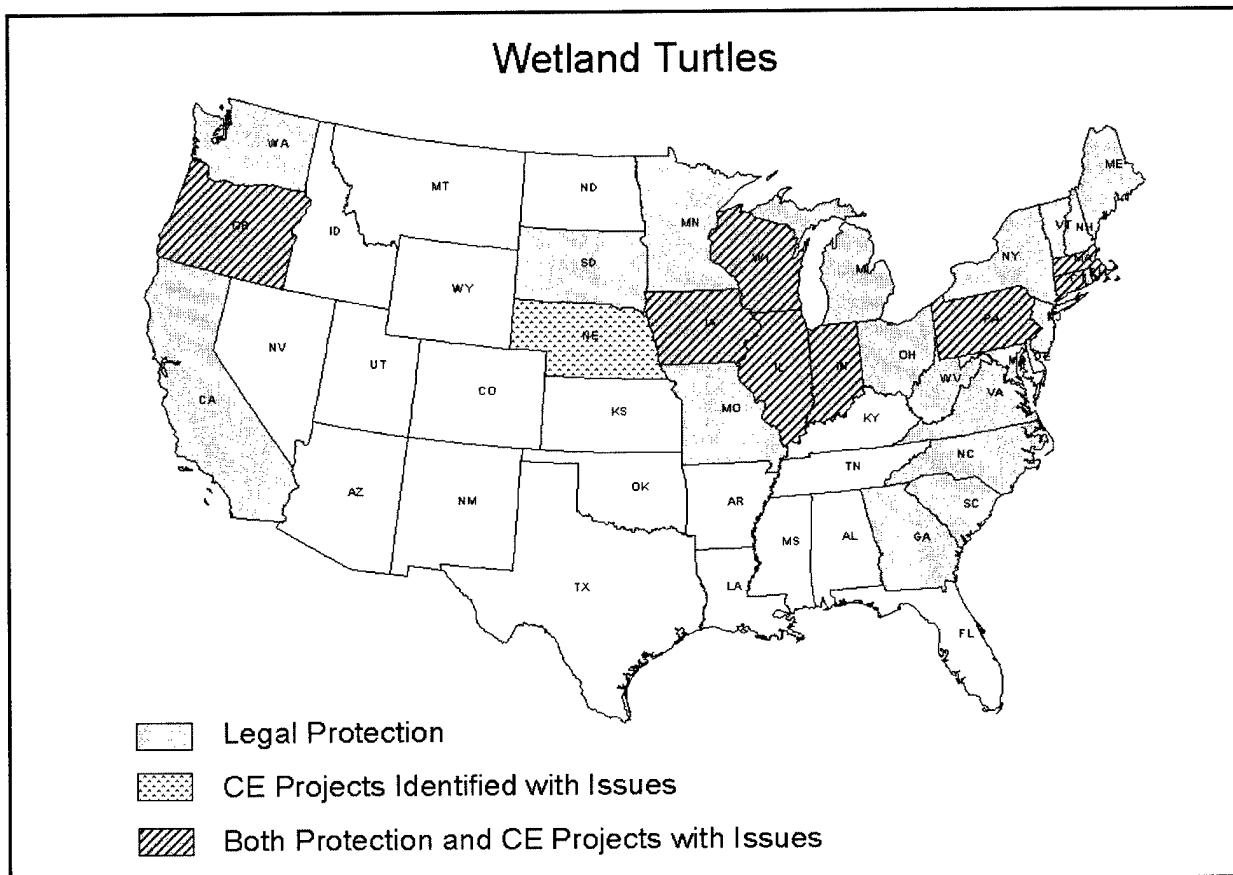


Figure 1. Legal protection status

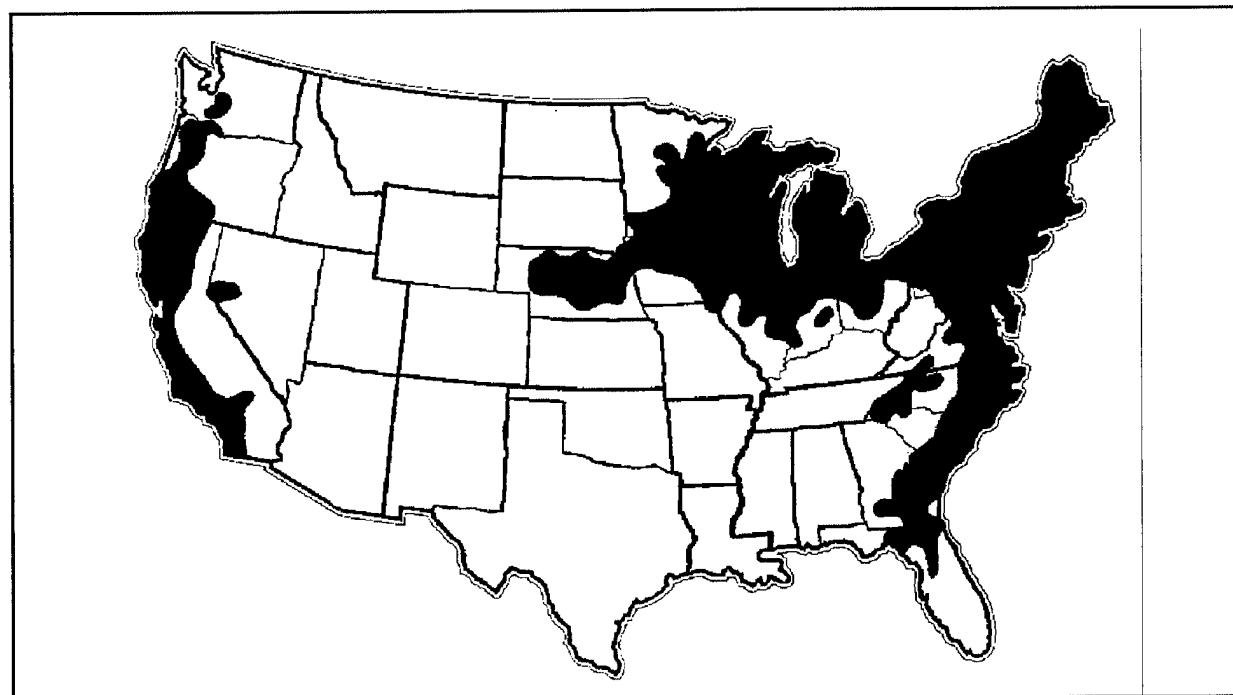


Figure 2. Wetland turtle habitat range

Table 2
Turtle Protection Status by Species

		North Atlantic States										South Atlantic States					
Turtle Species		ME 1/95	NH 1/98	VT 3/98	MA 11/97	CT 95	RI 95	NY 2/97	PA 1/94	NJ 6/96	DE 3/97	MD 11/94	VA 5/92	NC 9/94	SC 1/98	GA 10/97	FL 8/97
Blanding's turtle	FC	E	SSC	T			T	SC									
Bog turtle	FT			SE/FT	SE/FT	FT	SE/FT	SE/FT	SE/FT	SE/FT	SE/FT	FT	SE/FT	FT	FT	FT	
Wood turtle			SSC	SSC	SSC	SSC		SSC	SSC	T	SSC	T					
Spotted turtle	T	SSC	T	SSC	SSC	SSC		SSC	SSC	SSC	SSC		PHR	SSC	SSC		
Western pond turtle																	

		Midwest States								Southwest States				Pacific States				
Turtle Species		ID 9/97	MT 3/97	WY 1/97	CO 7/95	KS 6/93	NE 5/94	ND 97	SD 3/96	NM 12/97	AZ 1/97	NV 5/94	UT 3/97	CA 3/97	OR 12/96	WA 7/93	HI 1/97	AK 9/93
Blanding's turtle	FC							E										
Bog turtle	FT																	
Wood turtle																		
Spotted turtle																		
Western pond turtle			SSC											SSC	SSC	E		

		North Central States								Gulf States								
Turtle Species		KY 11/97	MO 6/97	IA 1/98	MN 7/96	WI 12/97	IL 4/97	94	OH 9/97	MI 6/94	WV 1/97	TX 11/97	LA 1/97	MS 6/96	AL 11/97	OK 4/93	AR 6/96	TN 9/94
Blanding's turtle	FC		E	T	T	E			SSC									
Bog turtle	FT																	
Wood turtle				E	T	T						SSC	PHR				FT	
Spotted turtle						E	E	SSC	SSC	PHR								
Western pond turtle																		

FT Federally threatened
FC Candidate for Federal protection
SSC State species of special concern
T or ST State threatened
E or SE State endangered
PHR Possession and/or harvesting regulations
Shading Indicates species with potential issues at CE Reservoirs

Profile: Blanding's turtle (*Emydoidea blandingii*)

Distribution: Blanding's turtle is a semiaquatic species found from southwestern Quebec and southern Ontario south through the Great Lakes region, and west to Iowa, northeastern Missouri, southeastern South Dakota, and west-central Nebraska. Scattered localities include southeastern New York, eastern Massachusetts, southern New Hampshire, and adjacent Maine, and Nova Scotia (Graham et al. 1987). The species has crossed Lake Erie to northwestern Pennsylvania (Ernst 1985).

Habitat: This species is found in productive, eutrophic habitats, with clean shallow water, a soft but firm organic bottom, and abundant aquatic vegetation. It is found in lakes, ponds, marshes, creeks, wet prairies, and sloughs.

Behavior: The Blanding's turtle is primarily active during daylight hours, especially during morning hours. It frequently basks on muskrat lodges, steep banks of dikes and ditches, stumps, logs, piles of driftwood, sedge clumps, and cattail debris. Basking generally occurs from 0800-1730 hr (water temperature 15-27 °C) under sunny to partly cloudy conditions. At night, the Blanding's turtle sleeps suspended in aquatic vegetation or on pond bottoms beneath aquatic vegetation (Rowe and Moll 1991). Turtles are active from late March until September (varies geographically). Hibernation generally begins between September and November when water temperatures drop to 6-13 °C.

Reproduction: Courtship and mating have been observed in every month from March to November, but are most common from March to July (Vogt 1981). The nesting season lasts from late May to early July, depending on geographic location and weather conditions (Rowe 1992). The flask-shaped nests are dug with the hind limbs and are usually completed at night by 2300 hr. Some turtles have demonstrated site fidelity. Only a single clutch (3-22 eggs total; \bar{x} range 10-15) is deposited yearly (Ernst et al. 1994; Joyal 1996). Incubation time varies as a function of temperature. Laboratory studies showed incubation times from 47 to 82 days (Ewert 1979). In a Michigan study (Ewert 1979), hatchlings emerge from the middle of August to early October; the time between laying and emergence is 73-104 days ($\bar{x}=84$). Gender determination is temperature-dependent.

Food habits: Crayfish account for 50 percent of their diet, but insects (e.g., Odonata, Coleoptera, Diptera), fish and their eggs, frogs and plant material (filamentous algae and duckweed) are also ingested (Kofron and Schreiber 1985).

Populations: Sex ratios of Blanding's turtle population range from essentially 1:1 to strongly female-biased (Congdon and van Loben Sels 1991). Density (turtles per hectare) in various locations include: 8.8-10 (Michigan), 27.5 (Wisconsin), 55.0 (Missouri), and 6.3 (Massachusetts). Wetland alteration or destruction is believed to be an important factor in the decline of several populations of Blanding's turtles (Kofron and Schreiber 1985). In addition to habitat destruction, the pet trade industry has also been attributed to population declines throughout its range.

Remarks: *Protection Status:* Federal: Federal candidate for protection; Endangered: Maine, Montana, Indiana, and South Dakota; Threatened: Massachusetts, New York, Minnesota, and Wisconsin; State species of special concern: New Hampshire, Pennsylvania, and Michigan.

Profile: Bog turtle (*Clemmys muhlenbergii*)

Distribution: The main range of the bog turtle extends from western Massachusetts, Connecticut, and eastern New York southward through eastern Pennsylvania and New Jersey to northern Delaware and northern Maryland. Isolated populations exist in northwestern New York, northwestern Pennsylvania, southern Virginia, western North Carolina, northwestern South Carolina, northern Georgia, and eastern Tennessee.

Habitat: The bog turtle lives in spring-fed sphagnum bogs, tamarack, black spruce swamps and marshy meadows (southern range) (Herman and Pharr 1986). Clear, slow moving rivulets or brooks with soft, highly organic substrates are required habitat features (Pitts 1978). Additional habitat requirements include substrates of soft mud and rock, vegetation dominated by low grasses and sedges, and a heterogeneous habitat with wet and dry areas (northern range) (Chase et al. 1989).

Behavior: The bog turtle is primarily diurnal, although nocturnal feeding, breeding, and nesting have been reported (Holub and Bloomer 1977). Emergence from cover occurs in early morning to begin basking activities, which continue until the turtle moves off in search of mates or food. Bog turtles are generally active at air temperatures between 16 and 31 °C (Herman 1981). Estivation may occur as temperatures rise during the summer. Hibernation begins from late September to November and ends in March or April. Tracking studies indicate homing behavior.

Reproduction: The nesting season lasts from May to July (Ernst and Barbour 1972). Nesting activity occurs in late afternoon or early evening hours. Nesting occurs away from wetter areas in elevated sedge tussocks or sphagnum moss above the waterline. Nests are generally exposed to sunlight most of the day. Other nesting sites include the soft soil above springs, adjacent pastures, or the sides of railroad embankments. Nests are generally dug with hind limbs; however, some nests are made by turtles tunneling through the tussock, depositing their eggs behind them as they crawl. Clutches consist of one to six eggs. Incubation varies as a function of temperature, lasting from 42 to 80 days (Tyron and Hulsey 1977). Hatchlings emerge in late August and September. Overwintering may occur in nests by hatchlings.

Food habits: The bog turtle feeds primarily on insects and berries either while on land or in the water. Other food items include beetles, seed of pondweed, snails, caddisfly larvae, millipedes, Japanese beetles, frogs (e.g., bullfrogs, pickerel), crickets, slugs, nestling birds, crayfish, dead water snakes, butterflies, salamanders, earthworms, mice, skunk, cattails and duckweed (Zappalorti 1976; Holub and Bloomer 1977)

Populations: Studies indicate population densities range from 49-62 turtles per hectare (New Jersey), 7-213 turtles per hectare (Maryland), and 125 to 140 turtles per hectare (Pennsylvania) (Chase et al. 1989). Sex ratios (female to male) have varied from 1:1 (Maryland) to 2.5:1 (New Jersey). Humans posed the major threat to survival. Destruction of wetland habitat and collection for the pet trade have caused extinction of some populations (Collins 1990) and severely reduced others.

Remarks: *Protection Status:* Federally threatened: New Hampshire, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, New Jersey, Delaware, Virginia, North Carolina, South Carolina, Georgia, Tennessee; State endangered: Massachusetts, Connecticut, New York, Pennsylvania, New Jersey, Delaware, and Virginia.

Profile: Wood turtle (*Clemmys insculpta*)

Distribution: The wood turtle range extends from Nova Scotia and New Brunswick south to Rockingham County, Virginia (Buhlmann and Mitchell 1989), and west to southern Quebec, southern Ontario, and New York to northern Michigan, Wisconsin, eastern Minnesota, and northeastern Iowa.

Habitat: Always found in close association with water, but the degree of association varies geographically. Harding (1991) reported wood turtles in Michigan and Wisconsin occupying habitats in or near moving water including rivers, streams, and associated shoreline habitats. Aquatic habitats consisting of hard sand or gravel bottoms are preferred over those with soft clay or muck bottoms. Moderate current and clear streams are also preferred. Other habitats include swamps, bogs, wet meadows, upland fields and pastures and the matrix of habitats in between (Ross et al. 1991).

Behavior: The wood turtle is primarily diurnal, but mating and nesting behavior may continue until 2300 hr. At night, turtles rest in sheltered areas of creeks or shallow forms on land (Kaufmann 1992). Turtles are active between 0700 and 1900 hr, with 85 percent of all sightings occurring between 1000 and 1500 hr. Wood turtles are active at air and water temperatures as low as 3 °C and 6 °C, respectively, but feeding does not start until water temperatures reach 15 °C (Ernst 1986). Wood turtles spend the majority of the day basking (primarily in the late morning and afternoon) on sunny days. Emergent logs are used by both sexes in spring and fall, but females prefer terrestrial sites during late June through August (Harding and Bloomer 1979). The wood turtle is primarily active from March through November (e.g. Pennsylvania) or April/May until early October (e.g. Michigan) (Harding 1991). Hibernation (varies geographically) begins in October and November. Most hibernate underwater in deep pools, under overhanging roots or logs along the stream, in beaver lodges, or muskrat burrows (Ernst and McBreen 1991; Farrell and Graham 1991). Hibernating groups of up to 70 turtles have been reported in New Jersey (Bloomer 1978). Individuals may show site fidelity with regards to hibernation (Garber 1989). Tracking studies indicate homing ability (Harding and Bloomer 1979). Aggressive behavior has been observed between males (Kaufmann 1992).

Reproduction: Mating can occur any time during the active season but peaks occur in spring and fall at water temperatures ranging from 10-20 °C (Ernst 1986). The nesting season lasts from May to early July depending on geographic location (Ernst and McBreen 1991). Nesting usually occurs in the afternoon and may continue until 2315 hr. Although the nest cavity is usually dug with the hind feet, females in New Jersey sometimes use their forelimbs to excavate (Farrell and Graham 1991). Requirements for nest sites include ample exposure to direct sunlight, well-drained but moist sand or soil substrate not subjected to flooding, and a substrate free of rocks and thick vegetation (Harding and Bloomer 1979). Only one clutch of 4-18 eggs (varies geographically, $\bar{x} = 10.4$ in Michigan, 8.5 in New Jersey, 11 in Wisconsin) is laid yearly (Harding and Bloomer 1979; Farrell and Graham 1991; Brooks et al. 1992). Incubation time (laboratory) ranges from 67 days at 25-25.5 °C to about 40 days at temperatures above 30 °C (Ewert 1979). Gender is not temperature-dependent (Ewert and Nelson 1991). Hatchlings emerge from mid-August to mid-October. No overwintering has been observed (Harding 1991).

Food habits: The species is omnivorous and consumes the green leaves of strawberries in April and May, strawberries and blackberries in June and August (Farrell and Graham 1991), and fungi, invertebrates, and various flowers and fruits (Strang 1983). Other food items include algae, moss, leaves of willows, mollusks, insects, earthworms, tadpoles, possibly the eggs and young of nesting birds, and other turtle eggs (Reid and Nichols 1970, Harding and Bloomer 1979, Ernst and McBreen 1991).

Populations: Wood turtle density estimates for New Jersey range from 9.9 to 11.4 turtles/hectare (Farrell and Graham 1991) and 12.5 turtles/hectare (Harding and Bloomer 1979). Overcollecting and habitat destruction are cited as reasons for declining populations. Wood turtles are especially vulnerable to increased mortality because of slow growth, late maturity, and high natural mortality of eggs and juveniles.

Remarks: *Protection Status:* Endangered: Idaho; Threatened: Minnesota, Wisconsin, New Jersey, Virginia; State species of special concern: New Hampshire, Vermont, Maryland, Connecticut, Rhode Island, New York, Maryland, Michigan; Possession and/or harvesting regulations: West Virginia.

Profile: Spotted turtle (*Clemmys guttata*)

Distribution: The spotted turtle range extends from southern Ontario, Quebec, and Maine southward along the Atlantic Coast and Piedmont to northern Florida and westward through Ontario, New York, Pennsylvania, central Ohio, northern Indiana, and Michigan to northeastern Illinois.

Habitat: The spotted turtle is found in a wide variety of shallow wetland habitats including swamps, bogs, fens, wet pastures, marshes, the edges of Carolina bays and ponds, tidally influenced brackish streams, and small woodland streams (Nemuras 1966). Habitat requirements include soft substrate and some aquatic vegetation.

Behavior: This species is active during daylight hours only, with the exception of nesting females. After darkness, the bog turtle will bury itself into the mud bottom of the wetland or crawl into mammals' burrows and become inactive until dawn. Activity begins at sunrise, with turtles basking until warm or foraging for food. Activity levels peak in May for all states except South Carolina, which peaks in March, and decline in June for all states except South Carolina, which begins to decline in April. Activity is greatest in cooler weather (Activity: peak: 13.1-18.0 °C air temperature; reduced: 17.8- 22.3 °C air temperature). Turtles become dormant when water temperatures reach 32 °C. The spotted turtle is known to hibernate in congregations of up to 12 turtles of the same species.

Reproduction: For both sexes, maturity occurs within 7-10 years at a carapace length of 8.0 cm. Mating season varies geographically but generally occurs in April (can occur as early as March). Copulation can occur in water or on land. Water and air temperatures during courtship range from 8.8 to 18.9 °C, and 10.0 to 22.3 °C, respectively. The egg-laying season lasts from May to July, varying geographically (Chippindale 1989). Nesting takes places either in the late afternoon or evening, or in the morning. One or two clutches of one to eight eggs are deposited in a year (Wilson 1989). Nest sites include grass tussocks, hummocks, or moist sphagnum moss, and the loamy soil of marshy pastures (Chippindale 1989). The natural incubation period to hatching may last 70-83 days, although in captivity this period may be as short as 44 days (Ewert 1979). Overwintering of hatchlings in nests has been reported (Ernst 1975).

Food habits: Spotted turtles are omnivorous scavengers and feed in the water. Diet includes aquatic grasses, filamentous green algae, aquatic insect larvae, small crustaceans, snakes, tadpoles, salamanders, and fish (Ernst 1976). Animal food items may be eaten alive or as carrion.

Populations: The Illinois population has declined until relatively few spotted turtles now exist in that state (Johnson 1983). Spotted turtle numbers are also falling in other Midwestern states. Spotted turtle numbers are declining in many areas due to habitat destruction and collection for the pet trade (Lovich and Jaworski 1988).

Remarks: Protection Status: Endangered: Indiana and Illinois; Threatened: Maine, Vermont; State species of special concern: Michigan, New Hampshire, Massachusetts, Rhode Island, New York, New Jersey, Maryland, South Carolina, and Georgia. Possession and/or harvesting regulations: North Carolina and West Virginia.

Profile: Western pond turtle (*Clemmys marmorata*)

Distribution: Range extends primarily west of the Cascade-Sierra crest from western Washington to northern Baja, California. An isolated population is found in the interior-draining Mojave River of California as far into the Mojave Desert as Alton Canyon. Pond turtles have been collected on Vancouver Island, British Columbia, but these are believed to be escaped or released captives originally from the United States (Cook 1984).

Habitat: Typically riparian, most often living in sloughs, streams, and large rivers, although some may inhabit impoundments and irrigation ditches and other artificial bodies of water. In streams, pools are preferred over shallower areas (Bury 1972). Aquatic vegetation is almost always present along with basking sites, although the river bottom may either be rocky or muddy. Western pond turtles have been collected from brackish estuarine waters at sea level over 1800 m elevation in mountain streams (Stebbins 1954; Bury 1963).

Behavior: Turtles are generally active from late May to October (Bury 1972). In some areas of California, however, at east south of Shasta County, they may be active every month (Buskirk 1991). Hibernation occurs underwater, often in the mud bottom or a stream pool. During summer droughts, the western pond turtle may also bury itself in the soft mud bottom of a stream. The daily routine of the western pond turtle consists of a foraging period around sunrise (0530-0800) followed by a basking period (0800-dusk), with most basking occurring from 0900 to 1000 hr (Bury 1972). Basking usually occurs on rocks, logs, or on the bank, but may occur on tree branches that dip into the water from bank vegetation (Nussbaum et al. 1983). Basking rarely takes place by floating at the surface. Aggressive behavior may be initiated by a basking *C. marmorata* toward an approaching turtle (Bury and Wolfheim 1973). Other times are spent inactive in the water or foraging. While most foraging takes place earlier in the day, turtles may forage in the late afternoon or early evening during summer. During summer, these turtles move from pool to pool within the stream system.

Reproduction: Mating has been observed in the field in May, June, and late August and in captivity in late August and early September (Holland 1988; Buskirk 1991). The nesting season extends from late April through August, depending on the latitude; the peak period is late May to early July. Nests are dug either in the morning or evening and are generally located along stream or pond margins; however, nests have been found in fields over 100 m above and distant from the water. Rathbun et al. (1992) reported nesting in open, full-sun-light grassy areas with southern exposure. Clutch size ranges from 2 to 11 eggs ($\bar{x} = 6.3$ for 15 observed nests). As many as two clutches a year may be laid. The natural incubation period is unknown, and may vary with altitude and latitude (Ernst et al. 1994). Laboratory incubation studies by Lardie (1975) and Feldman (1982) produced hatchlings in 73-81 days at 25-33 °C. Hatchling emergence may occur in late summer or fall, but Feldman (1982) and Buskirk (1991) suggested that some turtles overwinter in the nest and emerge the next spring.

Food habits: Known foods include: algae, various plants (including the pods of the yellow water lily), snails, crustaceans, isopods, insects (Coleoptera, Diptera, Ephemeroptera, Odonata, Orthoptera, Trichoptera, either as larvae, nymphs and/or adults), spiders, fish, and frogs (tadpoles and adults). Diets of adult males and females and of juveniles differ in prey size and proportions of prey items (Bury 1986). Males consume more insects and vertebrates while females consume more algae.

Populations: Populations are declining in southern California and over most of the northern range. Habitat destruction is given as the primary reason for declining populations (Brattstrom 1988, Brattstrom and Messer 1988). Today, only northern California and southern Oregon support extensive populations. The common name "western pond turtle" is a misnomer, as the species seldom lives in ponds. A more accurate common name would be the "western stream turtle."

Remarks: *Protection Status:* Endangered: Washington; State species of special concern: California, Oregon, and Idaho.

REFERENCES

Bloomer, T. J. (1978). "Hibernacula congregating in the *Clemmys* genus," *Journal of the Northern Ohio Association of Herpetology*.

Brattstrom, B. H. (1988). "Habitat destruction in California with special reference to *Clemmys marmorata*: A perspective," *Proceedings of the Conference on California Herpetology*. H. F. Delisle, P. R. Brown, B. Kaufman, and B. M. McGurty, eds. Southwest Herpetological Society, Van Nuys, CA, 13-24.

Brattstrom, B. H., and Messer, D. F. (1988). "Current status of the southwestern pond turtle, *Clemmys marmorata pallida*, in southern California," Final Report, California Department of Fish and Game, Contract C-2044.

Brooks, R. J., Shilton, C. M., Brown, G. P., and Quinn, N. W. S. (1992). "Body size, age distribution and reproduction in a northern population of wood turtles *Clemmys insculpta*," *Canadian Journal of Zoology* 70:462-69.

Buhlmann, K. A., and Mitchell, J. C. (1989). "*Clemmys insculpta* (wood turtle). USA: West Virginia," *Herpetological Review* 20:76.

Bury, R. B. (1963). "*Clemmys marmorata*," *American Amphibian Report* 100:1-3.

Bury, R. B. (1972). "Habits and home range of the Pacific pond turtle, *Clemmys marmorata*, in a stream community," Ph.D. diss., University of California, Berkeley.

Bury, R. B. (1986). "Feeding ecology of the turtle, *Clemmys marmorata*," *Journal of Herpetology* 20:515-21.

Bury, R. B., and Wolfheim, J. H. (1973). "Aggression in free-living pond turtles (*Clemmys marmorata*)," *Bioscience* 23:659-62.

Buskirk, J. R. (1991). "An overview of the western pond turtle, *Clemmys marmorata*," *Proceedings of the First International Symposium on Turtles and Tortoises: Conservation and Captive Husbandry*. K. R. Bearman, F. Caporaso, S. McKeown, and M. D. Graff, eds., Chapman University, Orange, CA, 16-23.

Chase, J. D., Dixon, K. R., Gates, J. E., Jacobs, D., and Taylor, G. J. (1989). "Habitat characteristics, population size, and home range of the bog turtle, *Clemmys muhlenbergii*, in Maryland," *Journal of Herpetology* 23:356-62.

Chippindale, P. (1989). "Courtship and nesting records for spotted turtles, *Clemmys guttata*, in the Mer Bleue Bog, southeastern Ontario," *Canadian Field-Naturalist* 103:289-91.

Collins, D. E. (1990). "Western New York bog turtles: Relicts of ephemeral islands or simply elusive?," *Ecosystem management: Rare species and significant habitats. Proceedings of the 15th Annual Natural Areas Conference*, R. S. Mitchell, C. J. Sheviak, and D. J. Leopold, eds., Bulletin No. 471, New York State Museum, 151-53.

Congdon, J. D., and van Loben Sels, R. C. (1991). "Growth and body size in Blanding's turtles (*Emydoides blandingii*): Relationships to reproduction," *Canadian Journal of Zoology* 69:239-245.

Cook, F. R. (1984). "Introduction to Canadian amphibians and reptiles," National Museum of Canada, Ottawa.

Ernst, C. H. (1975). "Growth of the spotted turtle, *Clemmys guttata*," *Journal of Herpetology* 9:313-18.

Ernst, C. H. (1976). "Ecology of the spotted turtle, *Clemmys guttata* (Reptilia, Testudines, Testudinidae), in southeastern Pennsylvania," *Journal of Herpetology* 10:25-33.

Ernst, C. H. (1985). "Blanding's turtle, *Emydidea blandingii* (Holbrook)," *Species of special concern in Pennsylvania*. H. H. Genoways and F. J. Brenner, eds., Carnegie Museum of Natural History Special Publication 11, Pittsburgh, PA, 293-94.

Ernst, C. H. (1986). "Environmental temperatures and activities in the wood turtle, *Clemmys insculpta*," *Journal of Herpetology* 20:222-29.

Ernst, C. H., and Barbour, R. W. (1972). *Turtles of the United States*. University of Kentucky Press, Lexington.

Ernst, C. H., and McBreen, J. F. (1991). "Wood turtle, *Clemmys insculpta* (Leconte)," *Virginia's endangered species*. Terwilliger, K., ed., McDonald and Woodward Publishing Company, Blacksburg, VA, 455-57.

Ernst, C. H., Lovich, J. E., and Barbour, R. W. (1994). *Turtles of the United States and Canada*. N. P. Dutro, ed., Smithsonian Institution.

Ewert, M. A. (1979). "The embryo and its egg: Development and natural history," *Turtles: Perspectives and research*. M. Harless and H. Morlock, eds., John Wiley & Sons, New York, 333-413.

Ewert, M. A., and Nelson, C. E. (1991). "Sex determination in turtles: Diverse patterns and some possible adaptive values," *Copeia* 1991:50-69.

Farrell, R. F., and Graham, T. E. (1991). "Ecological notes on the turtle *Clemmys insculpta* in northwestern New Jersey," *Journal of Herpetology* 25:1-9.

Feldman, M. (1982). "Notes on reproduction in *Clemmys marmorata*," *Herpetological Review* 13:10-11.

Garber, S. D. (1989). "A comparison of two populations of *Clemmys insculpta*, the North American wood turtle," *Plastron Papers* 19:32-35.

Graham, T. E., Forsberg, J. E., and Albright, J. J. (1987). "Updated distribution of Blanding's turtle, *Emydoidea blandingii* in Maine," *Bulletin of the Maryland Herpetological Society* 23:119-21.

Harding J. H. (1991). "A twenty year wood turtle study in Michigan: Implications for conservation," *Proceedings of the First International Symposium on Turtles and Tortoises: Conservation and Captive Husbandry*. K. R. Beaman, F. Caporaso, S. McKeown, and M. D. Graff, eds., Chapman University, Orange, CA, 31-35.

Harding, J. H., and Bloomer, T. J. (1979). "The wood turtle, *Clemmys insculpta*...a natural history," *HERP, Bulletin New York Herpetological Society* 15(1):9-26.

Herman, D. W. (1981). "Status of the bog turtle in the southern Appalachians," *Proceedings of the Nongame/Endangered Wildlife Symposium*. Technical Bulletin WL-5, Georgia Department of Natural Resources, Game and Fish Division, 77-80.

Herman, D. W., and Pharr, R. D. (1986). "*Clemmys muhlenbergii* (bog turtle). Elevation," *Herpetological Review* 17:24.

Holland, D. C. (1988). "*Clemmys marmorata* (western pond turtle) behavior," *Herpetological Review* 19:87-88.

Holub, R. J., and Bloomer, T. J. (1977). "The bog turtle, *Clemmys muhlenbergii* . . . A natural history," *Herpetological Bulletin* New York Herpetological Society 13(2):9-23.

Johnson, K. A. (1983). "The decline of the spotted turtle, *Clemmys guttata*, in northeastern Illinois," *Bulletin of Chicago Herpetological Society* 18:37-41.

Joyal, L. A. (1996). "Ecology of Blanding's (*Emydoidea blandingii*) and spotted (*Clemmys guttata*) turtles in southern Maine; population structure, habitat use, movements, and reproductive biology," M.S. thesis, University of Maine.

Kauffmann, J. H. (1992). "Habitat use by wood turtles in central Pennsylvania," *Journal of Herpetology* 26:315-21.

Kofron, C. P., and Schreiber, A. A. (1985). "Ecology of two endangered aquatic turtles in Missouri: *Kinosternon flavescens* and *Emydoidea blandingii*," *Journal of Herpetology* 19:27-40.

Lardie, R. L. (1975). "Notes and eggs and young of *Clemmys marmorata marmorata* (Baird and Girard)," Occasional Paper, Museum of Natural History, University of Puget Sound (47):654.

Lovich, J. E., and Jaworski, T. R. (1988). "Annotated checklist of amphibians and reptiles reported from Cedar Bog, Ohio," *Ohio Journal of Science* 88:139-43.

Nemuras, K. T. (1966). "Spotted turtles in Maryland," *Herpetological Bulletin*. New York Herpetological Society. 3(1):6-9.

Nussbaum, R. A., Brodie, E. D., Jr., and Storm, R. M. (1983). *Amphibians and reptiles of the Pacific Northwest*. University Press of Idaho, Moscow.

Pitts, N. (1978). "Soil maps on trail of bog turtle," *Soil Conservation* 42:22-23.

Rathbun, G. B., Siepel, N., and Holland, D. (1992). "Nesting behavior and movements of western pond turtles, *Clemmys marmorata*," *Southwest Naturalist* 37:319-24.

Reid, M., and Nichols, A. (1970). "Predation by reptiles on the periodic cicada," *Bulletin of the Maryland Herpetological Society* 6:57.

Technical Note EMRRP-SI-04

April 1999

Ross, D. A., Brewster, K. N., Anderson, R. K., Ratner, N., and Brewster, C. M. (1991). "Aspects of the ecology of wood turtles, *Clemmys insculpta*, in Wisconsin," *Canadian Field-Naturalist* 105:363-67.

Rowe, J. W. (1992). "Observations of body size, growth, and reproduction in Blanding's turtle (*Emydoidea blandingii*) from western Nebraska," *Canada Journal Zoology* 70:1690-695.

Rowe, J. W., and Moll, E. O. (1991). "A radiotelemetric study of activity and movements of the Blanding's turtle (*Emydoidea blandingii*) in northeastern Illinois," *Journal of Herpetology* 25:178-85.

Stebbins, R. C. (1954). *Amphibians and reptiles of western North America*. McGraw Hill Book Company, Boston, MA.

Strang, C. A. (1983). "Spatial and temporal activity patterns in two terrestrial turtles," *Journal of Herpetology* 17:43-47.

Tyron, B. W., and Hulsey, T. G. (1977). "Breeding and rearing the bog turtle *Clemmys muhlenbergii* at the Fort Worth Zoo," *International Zoo Yearbook* 17:125-30.

Vogt, R. C. (1981). *Natural history of amphibians and reptiles of Wisconsin*. Milwaukee Public Museum, Milwaukee, Wisconsin.

Zappalori, R. T. (1976). *The amateur zoologist's guide to turtles and crocodilians*. Stackpole Books, Harrisburg, PA.